Scanning Probe Microscopy Studies of Polycrystalline and Nanocrystalline Semiconductors

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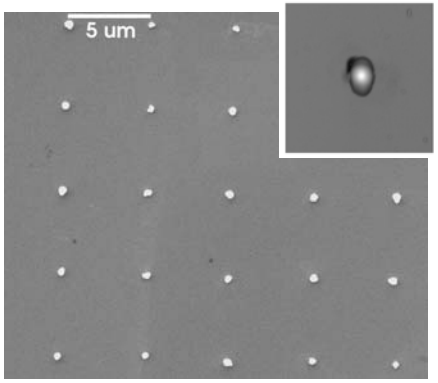
Selective growth of optically active semiconductors on low cost substrates can impact applications from integrated optics and microelectronics to terrestrial photovoltaics. We have developed a novel method for forming large GaAs crystallites at specific locations on Si substrates.

•Near field scanning photolithography and electrochemical deposition create submicron Ga "balls" on a Si surface.

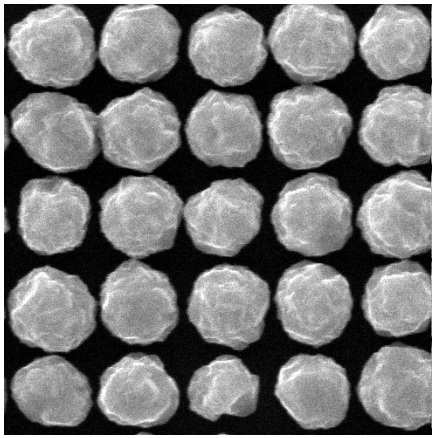
•Arsine anneals convert balls to GaAs seed crystals for subsequent lateral epitaxial growth of GaAs.

•Ordered arrays of GaAs crystallites as large as 15μm in diameter have been formed on Si.

Submitted to Appl. Phys. Lett.



SEM image of GaAs seed crystallites formed by annealing Ga balls in arsine. Inset is an enlarged AFM image of a Ga ball before anneal.



SEM image of GaAs crystal array after 3 minutes of selective growth on the seed crystallites

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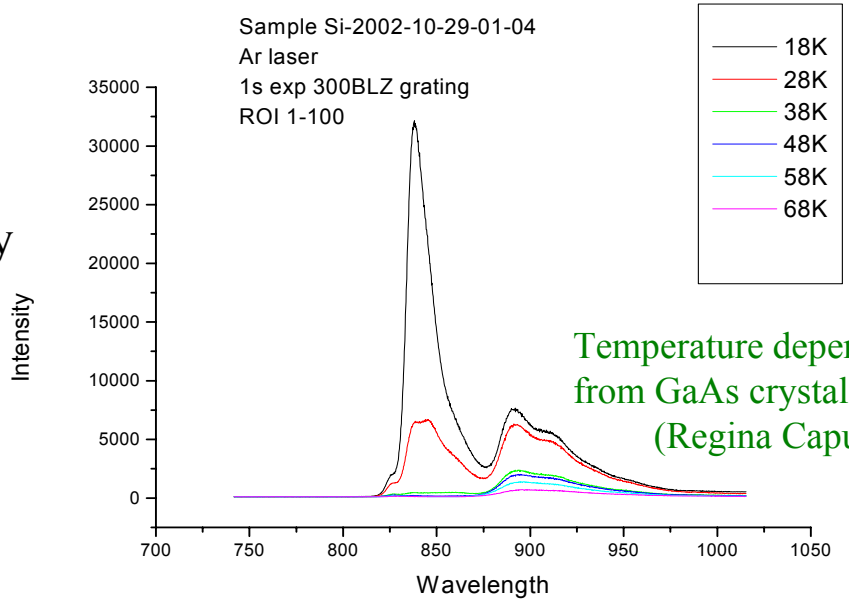
A central theme has been to involve undergraduate students in research early in their career.

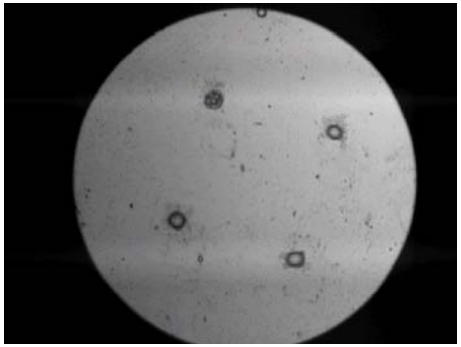
• Four undergraduates have been actively involved in the project through REU support.

•Students participate in group meetings, give conference presentations, write reports and are co-authors on papers.

•During summer 2003, students developed luminescence techniques (Regina Caputo), and a stamp lithography process to create nucleation sites for selective crystal growth (Josh Dorr).



Temperature dependent PL from GaAs crystallites (Regina Caputo)



Optical micrograph of patterned ammonium sulfate deposition on hydrophilic silicon regions created through stamp lithography. (Josh Dorr)